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Effect of Pharmacy-Supported Transition-of-Care Interventions on 30-Day Readmissions: A Systematic Review and Meta-analysis

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Abstract

Objective: To describe pharmacy-supported transition-of-care (TOC) interventions and determine their effect on 30-day all-cause readmissions. **Data Sources:** MEDLINE/PubMed, EMBASE, International Pharmaceutical Abstracts, ABI Inform Complete, PsychINFO, Web of Science, Academic Search Complete, CINHAL, Cochrane library, OIASTER, ProQuest Dissertations & Theses, ClinicalTrials.gov, and relevant websites were searched from January 1, 1995, to December 31, 2015. **Study Selection and Data Extraction:** PICOS+E criteria were utilized. Eligible studies reported pharmacy-supported TOC interventions compared with usual care in adult patients discharged to home within the United States. Studies were required to evaluate postdischarge outcomes (eg, rate of readmissions, hospital utilization). Randomized controlled trials, cohort studies, or controlled before-and-after studies were included. Two reviewers independently extracted data and evaluated study quality. **Data Synthesis:** A total of 56 articles were included in the systematic review (n = 61 858), of which 32 reported 30-day all-cause readmissions and were included in the meta-analysis. A taxonomy was developed to categorize targeted patients, intervention types, and pharmacy personnel as sole intervener. The meta-analysis demonstrated about a 32% reduction in the odds of readmission (odds ratio [OR] = 0.68; 95% CI = 0.61 to 0.75) observed for pharmacy-supported TOC interventions compared with usual care. Heterogeneity was identified (I^2 = 55%; $P < 0.001$). A stratified meta-analysis showed that interventions with patient-centered follow-up reduced 30-day readmissions relative to studies without follow-up (OR = 0.70; CI = 0.63 to 0.78). **Conclusions:** Pharmacy-supported TOC programs were associated with a significant reduction in the odds of 30-day readmissions.

Keywords

meta-analysis, clinical pharmacy, evidence-based practice, documentation interventions/outcomes, pharmaceutical care

Introduction

Hospital discharge is a vulnerable time for many patients as they transition to home or other health care facilities.[1] To help address this problem, the Centers for Medicare and Medicaid Services (CMS) has taken a special interest in evaluating the impact of transition-of-care (TOC) support in reducing readmissions. CMS introduced the Hospital Readmissions Reduction Program (HRRP) in 2012 to help decrease readmissions for targeted conditions that typically result in higher readmissions among beneficiaries.[2]

Implementation of the HRRP has been associated with a significant decline in hospital readmissions for both HRRP targeted and nontargeted conditions.[3] In 2015, approximately 17.8% of Medicare fee-for-service beneficiaries were readmitted within 30 days for at least one of CMS's HRRP targeted conditions compared with 21.5% in 2007. However, continued implementation and innovation of TOC programs is necessary because approximately 27% of readmissions are potentially avoidable[4] and incur an estimated economic burden of $25 billion to $45 billion annually.[5,6]

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Medication-related problems (MRPs) are estimated to be the largest cause of hospital readmissions (40%), and approximately 14% of medication-related hospital readmissions are preventable.[7,8] Several factors contribute to MRPs, including polypharmacy,[9] medication nonadherence, and high-risk mediations.[10,11] MRPs following hospital discharge may include adverse drug events,[12-14] unintended medication changes,[15,16] errors and discrepancies,[17] intentional and unintentional medication nonadherence,[18] and inappropriate medication prescribing.[19] If classified as a distinct disease, MRPs would rank as the fifth leading cause of death in the United States.[20] According to several studies, MRPs are also a major cause of morbidity and mortality and occur more commonly during the transition process.[8,12,13,21-24]

The frequency and preventability of medication-related readmissions underscores the need for improved medication management during and following hospitalization. As pharmacists' participation on medical rounds has been associated with significant reduction in adverse events,[25,26] integration of pharmacists into interdisciplinary TOC teams would likely be associated with similar reductions in MRPs. Therefore, professional organizations have produced "best practices" recommending the integration of pharmacy into interdisciplinary TOC teams to reduce readmissions.[27-29]

Qualitative research suggests that pharmacy-supported interventions are effective when (1) nurses and physicians are in close collaboration with pharmacists, (2) medication reviews occur on admission, (3) patient-tailored interventions are used, and/or (4) pharmacists are affiliated with the hospital.[30] Several systematic reviews[29-34] have used qualitative criteria to describe and identify the components (eg, collaboration and patient-tailored interventions) that the authors considered important to the impact of pharmacy-supported TOC programs. Kwan et al[29] and Mekonnen et al[32] have previously conducted meta-analyses evaluating the impact of medication reconciliation on clinical outcomes; however, these studies were limited to programs primarily focused on medication reconciliation. Currently, no quantitative evidence exists on the overall impact on readmissions of pharmacy-supported TOC programs that provide services beyond medication reconciliation. Furthermore, specific details (eg, intervention components, patients targeted) that may influence the TOC program's impact on readmissions have not been explored.

The objectives of this systematic review and meta-analysis were to (1) describe the types of pharmacy-supported TOC programs, (2) identify the patient populations targeted, (3) identify study-reported outcomes, (4) conduct a meta-analysis to estimate the impact of pharmacy-supported TOC programs on 30-day all-cause hospital readmissions, and (5) conduct stratified analyses to identify which factors influence readmissions.

Methods

Data Sources and Searches

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines[35] and was registered in the PROSPERO international registry of systematic reviews (CRD42015020536). English-language studies examining pharmacy-supported TOC interventions in the United States, published between January 1, 1995, and December 31, 2015, were identified. Studies specific to the United States were solely targeted because of the unique payer system mix and recent changes incorporated by government oversight in the past 20 years.[2] A systematic search was conducted, in collaboration with a medical research librarian (JM), using the following data sources: ABI Inform Complete (1971-2015), Academic Search Complete (1887-2015), EMBASE (1947-2015), CINAHL Plus with Full Text (1937-2015), ClinicalTrials.gov (2000-2015), Cochrane Library (1898-2015), International Pharmaceutical Abstracts (1970-2015), Dissertations and Theses (1861-2015), OAIster (1615-2015), PsycINFO (1600-2015), PubMed/MEDLINE (1946-2015), and Web of Science Core Collection (1900-2015). Additional sources included topic-relevant gray literature and the following professional association websites: American Society of Health-System Pharmacists, American Pharmacists Association, American College of Clinical Pharmacy, National Transitions of Care Coalition, Centers for Medicare & Medicaid Services, American Geriatrics Society, Institute of Medicine, Institute for Healthcare Improvement, The Care Transitions Program, Society of Hospital Medicine, and Agency for Healthcare Research and Quality. A hand search of reference lists of included studies and review articles was also conducted to identify additional studies. Key search terms included database-appropriate keywords and controlled vocabulary, including *health transitions, pharmacists, transitions of care*, and *pharmaceutical services*. Complete search strategies for each database are listed in Supplementary Appendix Table 1 (available at http://aop.sagepub.com/supplemental).

Study Selection

For inclusion in the systematic review, studies had to meet predefined PICOS + E requirements: specified population, intervention, comparator(s), outcome(s), study design, and exclusion criteria for study inclusion.[35] Eligible studies included patients 18 years and older with an inpatient admission discharged directly to home. Studies where patients were discharged from a hospital to another health care facility providing institutional care (eg, subacute rehabilitation, nursing facility, mental health facility, prison) were excluded. For inclusion, any pharmacy-supported TOC intervention had to be defined as such (ie, medication reconciliation, discharge medication counseling, postdischarge phone follow-up, or home visit) and have been conducted by pharmacy personnel

(eg, pharmacist, student pharmacist, pharmacy technician). Interventions could have occurred at any time during the TOC continuum (ie, admission, during hospitalization, discharge, postdischarge). Additional requirements for study inclusion were the following: comparison of pharmacy-supported care to usual care and a reported postdischarge outcome (eg, readmission rate, hospital utilization, MRPs). The usual care group was defined by each individual study and could include varying levels of services at the study site. Both randomized controlled trials (RCTs) and non-RCTs (prospective cohort, retrospective cohort, and controlled before-and-after) were included in this review.

Data Extraction and Quality Assessment

A dual review process was used for study inclusion assessment and data extraction, with teams of 2 reviewers assessing studies independently and meeting to resolve discrepancies. The authors involved in the review process (CRR, NM, JTH, EZB, KC) used standardized, study-specific article screening tools to review abstracts for study inclusion and extract data for included studies. Extracted data included the following: study and participant characteristics, targeted patient populations, TOC intervention components, and postdischarge outcomes.

The RCT and non-RCT tools from the Cochrane Collaboration were used to assess risk of bias.[36,37] The RCT risk-of-bias tool specified 6 domains for evaluation: (1) sequence generation (ie, random allocation sequence adequately specified to ensure comparable groups are produced), (2) allocation concealment (ie, random allocation concealment was explained satisfactorily), (3) blinding of outcome assessors (ie, whether knowledge of the allocated intervention was adequately prevented during the study), (4) incomplete outcome data (ie, if incomplete data were appropriately addressed), (5) selective outcome reporting (ie, if study results suggest selective outcome reporting), and (6) other sources of bias (ie, whether the study was seemingly void of other issues classified as high risk of bias). Given the nature of the interventions, blinding of participants and personnel is often not feasible and, therefore, was not assessed. Studies were rated as low-, unclear-, or high-risk of bias.

To satisfy the risk-of-bias assessment training, RCT study reviewers (CRR, NM, JTH, EZB, KC) independently evaluated 2 RCT studies.[38,39] Following the independent reviewer evaluation, any discrepancies in rating practices were discussed and resolved to ensure consistent risk rating of subsequent studies. Then, groups of 2 reviewers (NM and KC; JTH and EZB) independently assessed risk of bias, and differences were resolved through consensus after discussion with the primary author. If studies were included in Ensing et al,[30] a systematic review with overlapping studies, the authors only conducted 1 review and then compared their risk-of-bias assessment with that of Ensing et al.

For non-RCT studies, the Cochrane Risk of Bias Assessment Tool: for Non-Randomized Studies of Interventions (ACROBAT-NRSI) was used to evaluate potential for bias.[36] Non-RCT studies were assessed on 7 risk-of-bias domains: (1) confounding (ie, bias resulting from lack of adjustment for patient demographics, comorbidity severity case-mix, and/or prior hospitalization), (2) participant selection (ie, selection bias), (3) measurement of interventions (ie, misclassification, information, recall, measurement, and/or observer bias), (4) departures from intended interventions (ie, performance bias, time-varying confounding), (5) missing data (ie, attrition bias), (6) measurement of outcomes (ie, detection, recall, information, misclassification, observer, and/or measurement bias), and (7) selection of reported result (ie, outcome reporting and/or analysis reporting bias). Two authors (ARH, MKS) independently rated the non-RCT studies. For both RCT and non-RCT risk-of-bias ratings, any rating discrepancies were discussed and resolved among authors, and ratings were verified at each level of analysis.

Data Synthesis and Analysis

For each of the studies included in the systematic review, patient demographics, pharmacy practice setting, and individual study-reported primary outcomes were described. In certain cases, allowances were made to enable examination of the available study-reported primary outcomes. For example, when a specific primary outcome was not clearly stated; no comparison to usual care was made; and/or when more than 1 outcome was listed as a primary objective, the most relevant outcome with a comparison to usual care was reported, with preference given to 30-day all-cause readmissions. Targeted population and intervention component categories were generated to standardize reporting; these categories were stratified based on individual study-reported primary outcome results. The targeted patient populations were categorized as CMS HRRP admission diagnosis, history of chronic comorbidity, medication-related, other characteristics affecting TOC, and general patient population. TOC intervention components were categorized as medication reconciliation, patient counseling, improved medication access, discharge plan development, patient-centered follow-up, provider-centered follow-up, medication adherence tool given, or other. Elaborated definitions for targeted patient population and intervention component categories are listed in Table 1.

A meta-analysis was performed to assess the impact of pharmacy-supported TOC interventions on 30-day all-cause readmissions; the outcome was an odds ratio (OR) calculated for the pharmacy-supported interventions versus usual care groups in each study. When reported in the non-RCT

Table 1. Target Patient Population and Intervention Component Categorization Descriptions.

Category	Description
Target patient population	
CMS HRRP admission diagnosis	• Patients who were admitted for one of the following CMS HRRP diagnoses: heart failure, acute coronary syndrome (eg, acute myocardial infarction), chronic obstructive pulmonary disease, pneumonia, and/or total hip arthroplasty or total knee arthroplasty
History of chronic comorbidity	• Patients with a history of a certain chronic disease state. This chronic disease state did not have to be the admission diagnosis • When patients required a minimum number of comorbidities (more than one comorbidity) for inclusion into the study, this was subclassified as "multiple"
Medication related	• Patients targeted based on current medications documented at admission and/or discharge • This could include polypharmacy or a minimum number of medications; high-risk medications (eg, insulin, warfarin); high number of medication changes at discharge; or medication-related problems
Other characteristics affecting TOC	• Any other patient characteristic provided in the study inclusion criteria that was considered to affect transitions of care (eg, age greater than 60 years, concerns for self-management, prior hospitalization use)
General population	• A specific patient population or characteristic was not specified in the inclusion criteria, and the study included any adult patient from the site
Intervention component	
Medication reconciliation	• All activities that led to assembling an accurate medication list, including a check for appropriateness of prescribing and documentation of changes. • Subclassification for timing of intervention: A = at admission, I = during inpatient stay, D = at discharge, P = posthospitalization
Patient counseling	• Actively incorporating the patient as a source (or recipient) of information. • Subclassification for timing of intervention: A = at admission, I = during inpatient stay, D = at discharge, P = posthospitalization
Improved medication access	• Interventions aimed at improving access to medications (eg, bedside medication delivery, removed financial barriers)
Discharge plan development	• Patient provided with a discharge plan that may have included items such as emergency telephone numbers, a list of medications, follow-up appointments, and so on
Patient-centered follow-up	• Patient was engaged in follow-up after patient was discharged from the hospital • Subclassification of type of outreach: T = telephone call, H = home visit, C = clinic visit, M = multiple types
Health care provider–centered follow-up	• Consists of reporting medication-related problems(s) to primary care provider and/or communicating discharge plan to any health care provider
Medication adherence tool given	• Patient was provided with ways to improve taking medications as prescribed. This may include providing patients with pill box/organizer, medication calendars, or reminder tool

Abbreviations: CMS HRRP, Centers for Medicare and Medicaid Services Hospital Readmission Reduction Program; TOC, transition of care.

studies, the regression-adjusted outcome results were used.[40] Hence, ORs were used as the effect measure to include studies using covariates and reporting adjusted ORs. Outcome estimates were pooled, using a random effects model, to construct a forest plot to estimate the overall effect of pharmacy-supported TOC interventions on 30-day all-cause hospital readmissions. The a priori α level was 0.05.

To assess study variability, the I^2 measure was calculated to assess the extent to which the results of the studies were consistent. The I^2 measure yields a percentage of variability in effect estimates because of heterogeneity rather than sampling error (ie, chance).[41] Because the analyses included studies with various research designs, intervention components, and degrees of pharmacy involvement, the authors assumed that there was a high likelihood of variation in the outcomes between the studies. Therefore, stratified analyses were performed to assess the impact of the following on the 30-day readmission outcome measure: (1) intervention type (eg, patient-centered follow-up care, touchpoint frequency), (2) target population (eg, chronic comorbidities, medication-related inclusion criteria), and (3) study methods (eg, study design, multivariate analysis).

To assess publication bias, funnel plot asymmetry and Kendall's τ were evaluated.[42,43] A 1-study removed analysis, in which a single study is removed and the effect size recalculated so that the amount of effect that study has on the overall effect size can be ascertained, was done. Comprehensive Meta-Analysis Program software, version 2, was used for the analyses (Biostat, Inc, Englewood, NJ).

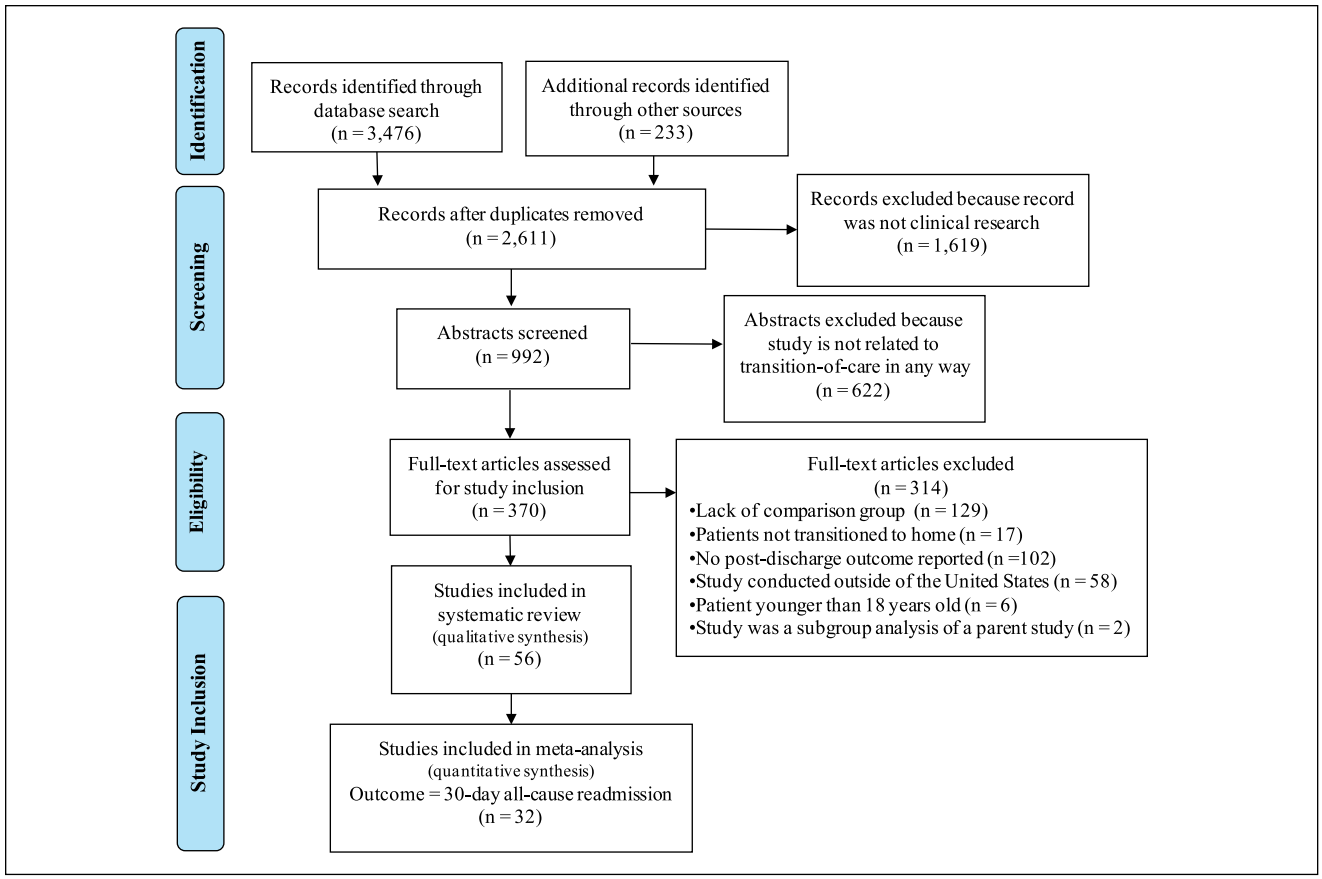

Figure 1. Flow diagram of literature search and included studies.

Results

Study Inclusion

The flowchart of study inclusion is displayed in Figure 1. Of the 2611 citations reviewed, 56 studies[38,39,44-97] were included in the systematic review, and 32 of those studies were analyzed in the meta-analysis.[38,44-74] Studies were excluded at the level of a full-text review for the following reasons: lack of a comparison group (n = 129), patients not transitioned directly home (n = 17), no postdischarge outcome reported (n = 102), study conducted outside of the United States (n = 58), inclusion of patients younger than 18 years (n = 6), and study being a subgroup analysis of a parent study (n = 2).

Systematic Review Results

Study Characteristics. Table 2 summarizes the characteristics of studies included in this review and meta-analysis. Patients' mean age ranged from 34 years[58] to 82 years,[65] and the percentage of males ranged from 15%[82] to 79%[63] for the included studies. The studies used different designs, including: RCT (n = 18), prospective cohort (n = 14), retrospective cohort (n = 12), and controlled before-and-after (n = 12). In total, 61 903 patients were included, with individual study sample sizes ranging from 25 unique patients[63] to 21 375 unique patients;[58] 4 studies[56,78,88,89] failed to report sample size. Usual care had varying definitions among the included studies. Studies may have had degrees of pharmacy involvement in the usual care group (eg, pharmacy rounding on medical teams); however, the usual care groups did not utilize pharmacy personnel to complete any TOC intervention. Most studies were conducted by pharmacy personnel practicing in hospital (n = 34, 61%) or clinic settings (n = 21, 38%). The 30-day all-cause readmission rate was the most common study-reported primary outcome (n = 24, 48%), followed by other readmission-related outcomes (eg, 60- or 90-day, disease-specific; n = 13, 23%), medication-related outcomes (n = 11, 20%), and other outcomes (n = 8, 14%). Study-reported outcome results ranged from favoring the intervention group (n = 25, 45%), showing a positive trend (n = 9, 16%), to showing no difference (n = 21, 38%) between the intervention and comparison groups. None of the studies showed results favoring the usual care group.

Table 2. Description of Included Studies.

Author, Publication Year	Study Design (Sample Size)	Patient Characteristics		Pharmacy Practice Setting	Primary Outcome		
		Mean Age (±SD)	Percentage Male		Results	*P* Value	Overall Effect
Anderegg et al, 2014[44]	Controlled before-and-after (3316)	• I: 54 (16) • C: 54 (17)	• I: 50 • C: 53	Hospital	Composite 30-day all-cause readmissions and ED visits • I: 23.4% • C: 22.6%	0.585	No difference (=)
Anderson et al, 2013[45]	Retrospective cohort (470)	• I: 57 (19-87)[a] • C: 55 (23-89)[a]	• I: 43 • C: 51	Clinic	30-Day all-cause readmissions • I: 10.6% • C: 19.8%	<0.01	Favors intervention (+)
Arnold et al, 2015[46]	Prospective cohort (334)	• I: 76 (12) • C: 74 (11)	• I: 53 • C: 59	Clinic	30-Day all-cause readmissions • I: 9.2% • C: 19.5%	0.023	Favors intervention (+)
Booth et al, 2014[47]	Controlled before-and-after (1298)	• I: 61 (14) • C: 61 (15)	• I: 42 • C: 42	Clinic	30-day all-cause readmissions • I: 12.5% • C: 18.1%	0.29	No difference (=)
Budiman et al, 2016[48,b]	Prospective cohort (136)	• I: 67 (13) • C: 63 (13)	• I: 78 • C: 79	Hospital	30-Day all-cause readmissions • I: 5.7% • C: 13.8%	0.18	No difference (=)
Calvert et al, 2012[75]	RCT (143)	• I: 63 (54-71)[a] • C: 62 (52-70)[a]	• I: 66 • C: 61	Hospital and community pharmacy	Percentage adherence to triple therapy at 6 months postdischarge • I: 91% • C: 94%	0.50	No difference (=)
Cavanaugh et al, 2014[49]	Retrospective cohort (104)	• I: 61 (14) • C: 61 (12)	• I: 35 • C: 56	Clinic	30-Day all-cause readmissions • I: 5% • C: 14%	0.023	Favors intervention (+)
Christy et al, 2016[50,b]	Prospective cohort (795)	• I: 54 (17) • C: 60 (18)	• I: 57 • C: 49	Hospital	30-Day all-cause readmissions • I: 5.7% • C: 13.8%	0.08	No difference (=)
Daley, 2010[76]	Prospective cohort (373)	• I: 73 • C: N/R	• I: 63 • C: N/R	Hospital	Average length of stay • I: 5.1 days • C: 6.7 days	N/R	Positive trend (+)
Dedhia et al, 2009[51]	Controlled before-and-after (422)	• I: 77 (8) • C: 77 (7)	• I: 38 • C: 40	Hospital	30-Day all-cause readmissions • I: 14% • C: 22%	<0.05	Favors intervention (+)
Dudas et al, 2001[52]	RCT (221)	• I: 57 (18) • C: 53 (20)	• I: 41 • C: 52	Hospital	Patient satisfaction with medication instruction (percentage very satisfied) • I: 86% • C: 61%	0.007	Favors intervention (+)
Eisenhower, 2014[77]	Controlled before-and-after (29)	• I: N/R • C: N/R	• I: N/R • C: N/R	Hospital	30-Day all-cause readmissions • I: 16% • C: 22.2%	N/R	Positive trend (+)
Englander et al, 2014[38]	RCT (382)	• I: N/R • C: N/R	• I: 59 • C: 59	Hospital	30-Day all-cause readmissions • I: 14.4% • C: 16.1%	0.644	No difference (=)

(continued)

Table 2. (continued)

Author, Publication Year	Study Design (Sample Size)	Patient Characteristics		Pharmacy Practice Setting	Primary Outcome		
		Mean Age (±SD)	Percentage Male		Results	*P* Value	Overall Effect
Farris et al, 2014[53]	RCT (945)	• I: 61 • C: 61	• I: N/R • C: N/R	Research center	Mean medication appropriateness index at 30 days postdischarge • E: 10.1 • M: 11.7 • C: 9.6	• E vs C = 0.78 • M vs C = 0.07	No difference (=)
Fera et al, 2014[54]	Retrospective cohort (175)	• I: N/R • C: N/R	• I: N/R • C: N/R	Hospital	30-Day all-cause readmissions • I: 14% • C: 23%	0.16	No difference (=)
Gil et al, 2013[55]	Retrospective cohort (100)	• I: 56 (17) • C: 57 (16)	• I: 48 • C: 48	Hospital	30-Day all-cause readmissions • I: 10% • C: 30%	0.012	Favors intervention (+)
Gilmore et al, 2015[78]	Controlled before-and-after (N/R)	• I: N/R • C: N/R	• I: N/R • C: N/R	Hospital and clinic	30-Day all-cause readmissions • I: 11.3% in FY2012 and FY12.2% in 2013 • C: 13.7%	N/R	Positive trend (+)
Gunadi et al, 2015[56]	Controlled before-and-after (N/R)	• I: N/R • C: N/R	• I: N/R • C: N/R	Hospital	30-day HF readmissions • I: 15% • C: 17%	N/R	Positive trend (+)
Hawes et al, 2014[57]	RCT (61)	• I: 63 • C: 63	• I: 49 • C: 49	Hospital and clinic	Composite 30-day all-cause readmissions and ED visits • I: 0% • C: 40.5%	<0.001	Favors intervention (+)
Ho et al, 2014[79]	RCT (253)	• I: 64 (9) • C: 64 (9)	• I: 98 • C: 98	Clinic	Medication adherence, mean portion of days covered • I: 0.94 • C: 0.87	<0.001	Favors intervention (+)
Imberg et al, 2012[80]	Controlled before-and-after (313)	• I: N/R • C: N/R	• I: N/R • C: N/R	Clinic	Percentage of MTM hospital follow-up encounters • I: 63.74 • C: 30.28%	<0.001	Favors intervention (+)
Jack et al, 2009[81]	RCT (738)	• I: N/R • C: N/R	• I: N/R • C: N/R	N/R	Composite 30-day all-cause readmissions and ED visits • I: 21.6% • C: 26.9%	0.009	Favors intervention (+)
Jackson et al, 2013[58]	Retrospective cohort (21 375)	• I: 40 • C: 34	• I: 40 • C: 39	Clinic	Number of readmissions following initial discharge (12-month analysis) • I: Between 7 and 32 fewer readmissions per 100 initial discharges for all risk strata • C: N/R	N/R	Positive trend (+)
Keller et al, 2013[59]	Controlled before-and-after (488)	• I: pre, 56 (16); post, 56 (16) • C: pre, 58 (14); post, 55 (15)	• I: pre, 60; post, 54 • C: pre, 69; post, 68	Hospital	Composite 60-day all-cause readmissions and ED visits • I: 27.9% • C: 28.6%	N/R	Positive trend (+)

(continued)

Table 2. (continued)

Author, Publication Year	Study Design (Sample Size)	Patient Characteristics		Pharmacy Practice Setting	Primary Outcome		
		Mean Age (±SD)	Percentage Male		Results	*P* Value	Overall Effect
Kilcup et al, 2013[60]	Retrospective cohort (494)	• I: 67 • C: 67	• I: 45 • C: 49	Clinic	30-Day all-cause readmissions • I: 12% • C: 14%	0.29	No difference (=)
Kirkham et al, 2014[61]	Retrospective cohort (19659)	• I: N/R • C: N/R	• I: 30 • C: 40	Community pharmacy	30-Day all-cause readmissions • I: 5% • C: 9.5%	0.05	Favors intervention (+)
Koehler et al, 2009[82]	RCT (41)	• I: 77 (6) • C: 80 (6)	• I: 15 • C: 38	Hospital	Composite 30-day all-cause readmissions and ED visits • I: 10% • C: 38.1%	0.04	Favors intervention (+)
Kogut et al, 2014[83]	Prospective cohort (30)	• I: N/R • • C: N/R	• I: 53 • C: 47	Clinic	Frequency of medication-related problems identified by pharmacist • I: 75% • C: 40%	0.06	Positive trend (+)
Kripalani et al, 2012[39]	RCT (851)	• I: 61 (14) • C: 59 (14)	• I: 59 • C: 58	Hospital	Mean number of clinically important medication errors per patient during first 30 days postdischarge • I: 0.87 • C: 0.95	>0.05	No difference (=)
Lipton and Bird, 1994[84]	RCT (706)	• I: 75 • C: 74	• I: N/R • C: N/R	Hospital	Medical care utilization using mean Medicare Part B charges at 30 days • I: 718 charges • C: 705 charges	0.46	No difference (=)
Musgrave et al, 2013[85]	Prospective cohort (192)	• I: 54 (22-72)[a] • C: 52 (1-78)[a]	• I: 69 • C: 66	Hospital and clinic	Number of discharge medication errors avoided per patient • I: 119 • C: 0	<0.001	Favors intervention (+)
Pal et al, 2013[74]	Prospective cohort (729)	• I: 57 (17) • C: 54 (18)	• I: 49 • C: 48	Hospital	30-Day all-cause readmissions • I: 16.8% • C: 26%	0.006	Favors intervention (+)
Paquin et al, 2015[86]	Retrospective cohort (501)	• I: N/R • C: N/R	• I: N/R • C: N/R	Clinic	60-Day all-cause readmissions • I: 25% • C: 37.1%	<0.05	Favors intervention (+)
Phatak et al, 2016[62,b]	RCT (278)	• I: 55 • C: 56	• I: 38 • C: 42	Hospital	Composite 30-day all-cause readmissions and ED visits • I: 24.8% • C: 38.7%	0.001	Favors intervention (+)
Pinelli et al, 2014[63]	Controlled before-and-after (25)	• I: 59 (10) • C: N/R	• I: 79 • C: N/R	Clinic	Mean change in hemoglobin A1C from baseline • I: 7.3 ± 1.2% • C: 8.1 ± 1%	0.07	No difference (=)

(continued)

Table 2. (continued)

Author, Publication Year	Study Design (Sample Size)	Patient Characteristics		Pharmacy Practice Setting	Primary Outcome		
		Mean Age (±SD)	Percentage Male		Results	*P* Value	Overall Effect
Powers et al, 2014[64]	RCT (62)	• I: N/R • C: N/R	• I: 44 • C: 29	Clinic	30-Day hospital readmissions • I: 23.5% • C: 25%	N/R	Positive trend (+)
Rainville, 1999[87]	RCT (34)	• I: 67 (9) • C: 73 (11)	• I: 47 • C: 53	Hospital and community pharmacy	1-Year composite heart failure readmissions or all-cause death • I: 29.4% • C: 82.3%	<0.01	Favors intervention (+)
Reichard et al, 2015[88]	Controlled before-and-after (N/R)	• I: N/R • C: N/R	• I: N/R • C: N/R	Hospital	Patient satisfaction as measured by HCAHPS and Press Ganey • I: N/R • C: N/R	N/R	No difference (=)[c]
Rice et al, 2016[89,b]	Prospective cohort (N/R)	• I: N/R • C: N/R	• I: N/R • C: N/R	Hospital	30-Day all-cause readmissions • I: 10.6% • C: 12.1%	<0.001	Favors intervention (+)
Ryan et al, 2014[65]	Controlled before-and-after (398)	• I: 82 (11) • C: 81 (12)	• I: 42 • C: 35	Hospital	30-Day all-cause readmissions • I: 18.2% • C: 25.4%	0.04	Favors intervention (+)
Schillig et al, 2011[90]	RCT (500)	• I: 64 (16) • C: 68 (15)	• I: 54 • C: 56	Hospital	Compliance rate of all transitions of care metrics • I: 75.6% • C: 2.8%	<0.001	Favors intervention (+)
Schnipper et al, 2006[92]	RCT (178)	• I: 61 (17) • C: 58 (16)	• I: 33 • C: 35	Hospital	Rate of preventable ADEs 30 days postdischarge • I: 1% • C: 11%	0.01	Favors intervention (+)
Schnipper et al, 2009[91]	RCT (322)	• I: N/R • C: N/R	• I: 48 • C: 43	Hospital	Potential ADE caused by unintentional medication discrepancies per patient • I: 1.05 • C: 1.44	<0.05	Favors intervention (+)
Sebaaly et al, 2015[66]	Prospective cohort (67)	• I: N/R • C: N/R	• I: N/R • C: N/R	Hospital	Mean number of errors identified per patient • I: 1.25 ± 2.04 errors • C: N/R	N/R	Positive trend (+)
Setter et al, 2009[93]	Prospective cohort (220)	• I: 75 (10) • C: 73 (10)	• I: 43 • C: 48	N/R	Mean number of medication discrepancies per patient • I: 2.1 • C: 2	N/R	No difference (=)
Shah et al, 2013[94]	RCT (127)	• I: 54 (13) • C: 57 (10)	• I: 56 • C: 60	Hospital	DM medication adherence rate at 150 days postdischarge: prescriptions of days covered method • I: 55.2% • C: 34.8%	0.002	Favors intervention (+)

(continued)

Table 2. (continued)

Author, Publication Year	Study Design (Sample Size)	Patient Characteristics		Pharmacy Practice Setting	Primary Outcome		
		Mean Age (±SD)	Percentage Male		Results	*P* Value	Overall Effect
Shaya et al, 2015[67]	Prospective cohort (101)	• I: 65 (10) • C: 63 (15)	• I: 39 • C:49	Clinic	30-Day initial reason for index hospitalization readmissions • I: 0% • C: 0%	N/R[d]	No difference (=)
Shcherbakova and Tereso, 2016[68,b]	Retrospective cohort (245)	• I: 78 (9) • C: 77 (9)	• I: 56 • C: 48	Clinic	30-Day all-cause readmissions • I: 10.3% • C: 6.7%	0.35	No difference (=)
Sides et al, 2012[95]	Prospective cohort (30)	• I: 61 (55-70)[a] • C: 59 (47-67)[a]	• I: 58 • C: 60	Hospital	Feasibility of the intervention: median length of coaching • I: 27 minutes • C: N/R	N/R	N/R
Still et al, 2013[69]	Retrospective cohort (748)	• I: 62 (15) • C: N/R	• I: 50 • C: N/R	Hospital	30-Day all-cause readmissions • I: 18.9% • C: 18.8%	0.98	No difference (=)
Stranges et al, 2015[70]	Retrospective cohort (1144)[e]	• I: 80 (8) • C: 81 (8)	• I: 34 • C: 37	Clinic	30-Day all-cause readmissions • I: 21 • C: 17.3	0.133[e]	No difference (=)
Tedesco et al, 2016[71,b]	Prospective cohort (79)	• I: 77 • C: 78	• I: 38 • C: 51	Clinic	30-Day all-cause readmissions • I: 14.7% • C: 26.7%	0.27	No difference (=)
Trang et al, 2015[96]	Controlled before-and-after (161)	• I: 56 (16) • C: 53 (14)	• I: 55 • C: 38	Clinic	Composite 30-day all-cause readmissions and ED visits • I: 23% • C: 41.4%	0.013	Favors intervention (+)
Triller and Hamilton, 2007[97]	RCT (154)	• I: 81 (9) • C: 78 (11)	• I: 27 • C: 28	Clinic	180-Day all-cause readmissions • I: 55% • C: 58%	0.63	No difference (=)
Truong and Backes, 2015[72]	Retrospective cohort (632)	• I: 68 (17) • C: 82 (9)	• I: 61 • C: 49	Hospital	30-Day all-cause readmissions • I: 12.3% • C: 23.8%	0.005	Favors intervention (+)
Walker et al, 2009[73]	Prospective cohort (724)	• I: 58 (19-95)[a] • C: 57 (19-97)[a]	• I: 46.1 • C: 48.1	Hospital	30-Day all-cause readmissions • I: 22.1% • C: 18%	0.17	No difference (=)

Abbreviations: A1C, percentage of glycosylated hemoglobin; ADE, adverse drug event; C, comparison group; DM, diabetes; E, enhanced intervention group; ED, emergency department; Favors intervention (+), study results favored the intervention if the study reported that the primary outcome was significantly lower compared with usual care; FY, fiscal year; HCAHPS, Hospital Consumer Assessment of Healthcare Providers and Systems; HF, heart failure; I, intervention group; Positive results (+), study results were positively trending in favor of the intervention when no *P* value was reported but the study-reported primary outcome was lower compared with usual care; M, minimal intervention group; MTM, medication therapy management; No difference (=), study results were no different if the study-reported primary outcome was not significantly different between intervention and usual care groups; N/R, not reported; RCT, randomized control trial; SD, standard deviation.

[a]Median age and interquartile range reported.

[b]Electronic publication (ePub) was utilized because it was located during the search timeframe; however, the final publication was in 2016.

[c]Based on text interpretation reported in the article.

[d]Unable to calculate *P* value.

[e]Intention-to-treat population reported.

Targeted Patient Populations. Table 3 delineates the patient populations targeted in each study. Patients targeted for TOC interventions varied across studies. Regarding targeted recruitment, medication-related reasons (n = 19, 34%) were most commonly reported, followed by CMS HRRP admission diagnoses (n = 15, 27%) and history of chronic comorbidities (n = 14, 25%). In all, 10 studies (18%) included the general patient population rather than selection based on targeted patient characteristics criteria. Patients targeted based on medication-related reasons included polypharmacy (n = 12, 63%), high-risk medications (n = 10, 52%), a high number of medication changes at discharge (n = 5, 26%), or MRPs (n = 3, 16%). Out of the studies that utilized a CMS HRRP admission diagnosis to target patients, heart failure was the most common HRRP diagnosis (n = 12, 80%). Half of the studies targeting patients with a history of a certain chronic disease included patients with diabetes (n = 7).

Pharmacy-Supported TOC Intervention Characteristics. Table 4 summarizes pharmacy-supported TOC interventions for each study. The most common interventions were patient counseling (n = 48, 86%), medication reconciliation (n = 45, 80%), and patient-centered follow-up (n = 45, 80%). Timing of interventions varied throughout the TOC continuum (ie, at admission, during hospitalization, at discharge, and/or postdischarge), with the most common timing of interventions being at postdischarge (n = 45, 80%) followed by at discharge (n = 32, 57%). Patient-centered follow-up was reported as a telephone call in 21 studies; a combination of either telephone, home, and/or clinic visit in 12 studies; a clinic visit in 8 studies; or a home visit in 4 studies. The majority of interventions were conducted with pharmacy personnel as the sole intervener (n = 37, 66%), whereas the remaining studies utilized pharmacy personnel as part of the TOC team.

Risk-of-Bias Assessment of Included Studies. Six categories were utilized to assess risk of bias for the RCT study designs (Supplementary Appendix Table 2), and 7 categories were used for non-RCT study design evaluation (Supplementary Appendix Table 3). Four RCT studies scored low risk of bias for all 6 categories.[39,62,79,81] High risk of bias was found in the allocation concealment category in 4 studies,[38,84,90,91] and other areas of bias identified as high risk included random sequence generation,[90] blinding of outcomes assessors and data analysts,[91] incomplete outcome data,[52] and selective outcome reporting.[97] There were insufficient data to permit judgment for random sequence generation (n = 5),[38,52,64,87,94] allocation concealment (n = 5),[52,57,64,87,94] blinding of outcomes assessors and data analysts (n = 10),[52,53,57,64,75,82,84,87,94,97] and other sources of bias categories (n = 7)[52,57,64,82,91,92,97] for the RCT studies. High risk of bias was identified in 68% of non-RCT studies for the predicted direction of bias as a result of confounding category,[44,46-48,50,51,54,56,63,65,66,69,71,72,74,76,77,78,83,85,88,89,93,96] indicating that most studies failed to perform an adjusted analysis to control for readmission cofounders such as prior hospitalizations and patient comorbidities. The predicted direction of bias resulting from selection of participants into the study category was also commonly scored as high risk of bias (n = 9),[46,50,51,58,59,69,74,76,77] indicating that the study groups were nonequivalent at baseline and, typically, no multivariate regression was used to control for differences. More than three-quarters of the studies did not report intervention fidelity (n = 28),[44-46,48,50,51,54-56,58-61,63,65-70,73,74,76,78,83,88,89,93] making it difficult to determine how comprehensively the interventions were implemented.

Meta-analysis Results

30-Day Readmissions Outcome. Of the 56 studies included, 32 (34 study arms) met the meta-analysis inclusion criteria and included 6 RCTs;[33,52,53,57,62,64] samples ranged from 61 patients[57] to 19 659 patients.[61] The forest plot of 30-day all-cause readmission ORs for the composite meta-analysis is shown in Figure 2. For the composite meta-analysis, the overall sample size was 32 538 patients (with 73 206 readmissions), with a significant reduction in the odds of all-cause 30-day readmission by about 32% (OR = 0.68; 95% CI = 0.61, 0.75) observed for pharmacy-supported TOC interventions compared with usual care. Significant heterogeneity was observed across studies (I^2 = 54%; $P < 0.001$). When stratified into subgroups, a meta-analysis showed a statistically significant difference ($P = 0.006$) between studies with a patient-centered follow-up component versus studies with no patient-centered follow-up (Table 5). Compared with those without a patient-centered follow-up component,[44,51,56,59,66,69,74] clinic visits[46,49,57,63,67] and combination care (ie, 2 or more types of follow-up provided)[38,54,58,64,70-72] showed significant reductions in the odds of readmission ($P = 0.009$ and $P = 0.003$, respectively); however, telephonic interventions[45,47,48,50,52,53,55,60-62,65,73] were statistically similar ($P = 0.052$). Furthermore, there were no differences in the odds of readmission between telephonic interventions relative to clinic visits ($P = 0.091$) or combination care ($P = 0.396$), nor between clinic visits and combination care ($P = 0.191$). Interestingly, there was a larger amount of heterogeneity in the no follow-up (I^2 = 36%; $P = 0.127$) and telephonic follow-up (I^2 = 23%; $P = 0.216$) groups relative to the clinic visit and combination care groups (I^2 = 0%, $P = 0.413$, and I^2 = 0%, $P = 0.702$, respectively). It was difficult to draw conclusions from the subgroup analyses involving home visits given that only 1 such study was included.[68] No other significant differences were found among the groups to reduce the odds of readmission with respect to (1) intervention types other than patient-centered follow-up care (Supplementary Appendix Table 4), (2) patient populations

Table 3. Categorization of Targeted Patient Population.[a]

Author, Publication Date	CMS HRRP Admission Diagnosis	History of Chronic Comorbidity	Medication Related	Other Characteristics Affecting TOC	General Population
Favors intervention[b]					
Anderson et al, 2013[45]					X
Arnold et al, 2015[46]			↑#Meds.		
Cavanaugh et al, 2014[49]					X
Dedhia et al, 2009[51]				Age ≥60	
Dudas et al, 2001[52]					X
Gil et al, 2013[55]			HRM	Self-mgmt. concerns, ↓Health Lit.	
Hawes et al, 2014[57]	ACS, COPD, HF		↑#Meds.	↑Hosp. use, Other[c]	
Ho et al, 2014[79]	ACS				
Imberg et al, 2012[80]			↑#Meds., Med. Δs, MRP	Self-mgmt. concerns	
Jack et al, 2009[81]					X
Kirkham et al, 2014[61]					X
Koehler et al, 2009[82,d]		Multiple	↑#Meds.	Age ≥60, Self-mgmt. concerns	
Musgrave et al, 2013[85]				Other[c]	
Pal et al, 2013[74]			↑#Meds.,[e] HRM[e]		
Paquin et al, 2015[86,d]				Age ≥60, Other[c]	
Phatak et al, 2016[62]			↑#Meds., HRM		
Rainville, 1999[87]	HF				
Rice et al, 2016[89]	HF[e]			↑Hosp. use[e]	
Ryan et al, 2014[65]	HF				
Schillig et al, 2011[90]			HRM		
Schnipper et al, 2006[92]					X
Schnipper et al, 2009[91]					X
Shah et al, 2013[94]		DM			

(continued)

Table 3. (continued)

Author, Publication Date	CMS HRRP Admission Diagnosis	History of Chronic Comorbidity	Medication Related	Other Characteristics Affecting TOC	General Population
Trang et al, 2015[96]		COPD, DM, HF	↑#Meds., HRM	Other[c]	
Truong and Backes, 2015[72]	HF				
Positive trend[f]					
Daley, 2010[76]	HF				
Eisenhower, 2014[77,d]	COPD			Age ≥60	
Gilmore et al, 2015[78]		DM, HF	HRM, MRP	↓Health Lit.	
Gunadi et al, 2015[56]	HF				
Jackson et al, 2013[58,d]		Multiple		Other[c]	
Keller et al, 2013[59]				Other[c]	
Kogut et al, 2014[83]		ASCVD, COPD, DM			
Powers et al, 2014[64,d]		HF		Age ≥60	
Sebaaly et al, 2015[66]					X
No difference[g]					
Anderegg et al, 2014[44]	ACS,[e] COPD,[e] HF[e]		HRM[e]		
Booth et al, 2014[47]				Other[c]	
Budiman et al, 2016[48]	ACS				
Calvert et al, 2012[75,d]		ASCVD	↑#Meds.		
Christy et al, 2016[50]					X
Englander et al, 2014[38]				Other[c]	
Farris et al, 2014[53]		ASCVD, COPD, HF	HRM		
Fera et al, 2014[54]	COPD, HF		↑#Meds.	Other[c]	
Kilcup et al, 2013[60]		Multiple	Med. Δs	Self-mgmt. concerns, ↑Hosp. use[h]	
Kripalani et al, 2012[39]	ACS, HF				

(continued)

Table 3. (continued)

Author, Publication Date	CMS HRRP Admission Diagnosis	History of Chronic Comorbidity	Medication Related	Other Characteristics Affecting TOC	General Population
Lipton and Bird, 1994[84,d]			↑#Meds.	Age ≥60	
Pinelli et al, 2014[63]		DM[i]			
Reichard et al, 2015[88]					X
Setter et al, 2009[93]		ASCVD, COPD, DM		Other[c]	
Shaya et al, 2015[67]		DM			
Shcherbakova and Tereso, 2016[68]				Other[c]	
Still et al, 2013[69,j]	ACS, COPD, HF	Multiple	↑#Meds., HRM, Med. Δs, MRP	Age ≥60, Self-mgmt. concerns, ↑Hosp. use	
Stranges et al, 2015[70]				Age ≥60	
Tedesco et al, 2016[71,d]				Age ≥60, Other[c]	
Triller and Hamilton, 2007[97]	HF				
Walker et al, 2009[73]			↑#Meds., HRM, Med. Δs	Self-mgmt. concerns	
Not reported[k]					
Sides et al, 2012[95,d]			Med. Δs	Other[c]	

Abbreviations: ACS, acute coronary syndrome or myocardial infarction; Age ≥60, patient age greater than 60 years; ASCVD, atherosclerotic cardiovascular disease; CMS HRRP, Centers for Medicare and Medicaid Services Hospital Readmission Reduction Program; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; ↓Health Lit., patients with low health literacy based on study-selected health literacy assessment tool HF, heart failure; ↑Hosp. use, patients with high hospital utilization identified based on past hospital admissions and/or emergency department use over a certain time frame; HRM, high-risk medication(s), which varied among studies but may include anticoagulants, antidiabetic agents, opioids, or BEERS criteria medications; Med. Δs, high number of medication changes at discharge; ↑#Meds., high number of medications at discharge or polypharmacy as defined by each study; MRPs, medication-related problems; Multiple, patients had to have more than 1 chronic disease state; Self-mgmt. concerns, patients who may have a difficult time self-managing their medical conditions or medications; TOC, transition of care; X, no specific patient population was reported in the study.

[a]Patients in each study were required for study inclusion to have one or more of the characteristics listed in the columns of this table unless otherwise specified.

[b]Study results favored the intervention if the study-reported primary outcome was significantly lower compared to usual care.

[c]Other = other targeted population as defined by each study, including the following: admission for stroke or transient ischemic attack;[57,95] abdominal transplant patient;[85] patients on medication(s) for dementia or patients at risk of developing dementia defined as cognitive impairment, sensory impairment, or dehydration;[86] diagnosis of HIV or pneumonia;[96] patients with Medicaid insurance;[58] patients with a consult to the infectious disease service;[59] patients discharged to medical resident clinic;[47] patients with low income and/or uninsured;[38] patients with complex medication regimens;[54] diagnosis of cardiac arrhythmia, major orthopedic surgery, or fracture;[93] patients with Medicare insurance.[68,71]

[d]Patients were required to meet all listed population characteristics for study inclusion.

[e]This patient characteristic was prioritized; there were no exclusion criteria.

[f]Study results were positively trending in favor of the intervention when no *P* value was reported, but the study-reported primary outcome was lower compared with usual care.

[g]Study results were no different if the study-reported primary outcome was not significantly different between intervention and usual care groups.

[h]Patients whose index admission was a readmission.

[i]Kidney transplant recipients only.

[j]Patients were required to meet one or more listed population characteristics for a total of 10 points for study inclusion.

[k]Study results were not reported in a manner such that statistical significance or trends for the primary outcome could be interpreted.

Table 4. Categorization of Intervention Components Performed.

Author, Publication Date	Medication Reconciliation	Patient Counseling	Improved Medication Access	Discharge Plan Development	Patient-Centered Follow-up	HCP-Centered Follow-up	Medication Adherence Tool Given	Other[a]
Pharmacy personnel as the sole intervener								
Favors intervention[b]								
Anderson et al, 2013[45]		P	X		T			
Arnold et al, 2015[46]	P				C			
Dudas et al, 2001[52]		P			T			
Hawes et al, 2014[57]	P	P			C	X		
Ho et al, 2014[79]	P	P			M	X	X	
Imberg et al, 2012[80]	P	P		X	C	X		
Kirkham et al, 2014[61]		D, P	X		T			
Musgrave et al, 2013[85]	D, P		X		C			
Pal et al, 2013[74]	D	D		X				
Paquin et al, 2015[86]	P	P			T	X		
Phatak et al, 2016[62]	A, D, P	D, P	X	X	T			
Schillig et al, 2011[90]		I, D, P		X	C	X		
Schnipper et al, 2006[92]	D, P	D			T	X		
Shah et al, 2013[94]		D						
Trang et al, 2015[96]	P	P			M	X	X	X
Truong and Backes, 2015[72]	A, D, P	D, P	X		M		X	
Positive trend[c]								
Eisenhower, 2014[77]	D					X		
Gilmore et al, 2015[78]	A, D, P	I, D, P	X		T	X	X	
Gunadi et al, 2015[56]	A, D	D	X				X	
Kogut et al, 2014[83]	P	P			H			
Sebaaly et al, 2015[66]	A, D							

(continued)

Table 4. (continued)

Author, Publication Date	Medication Reconciliation	Patient Counseling	Improved Medication Access	Discharge Plan Development	Patient-Centered Follow-up	HCP-Centered Follow-up	Medication Adherence Tool Given	Other[a]
No difference[d]								
Anderegg et al, 2014[44]	A, D	D					X	
Budiman et al, 2016[48]	I, P	D, P	X		T		X	
Calvert et al, 2012[75]	P	P			T		X	X
Christy et al, 2016[50]	D	D	X		T			
Farris et al, 2014[53]	A	I, D, P[e]	X[e]	X	T[e]	X	X	
Fera et al, 2014[54]	A, D, P	D, P		X	M	X	X	
Kilcup et al, 2013[60]	P	P			T	X		
Kripalani et al, 2012[39]	I, D	I, D			T	X	X	
Lipton and Bird, 1994[84]		D, P			M	X		
Pinelli et al, 2014[63]	P	P			C			
Shaya et al, 2015[67]	P	P			C	X		
Shcherbakova and Tereso, 2016[68]	P	P			H	X		
Still et al, 2013[69]	D	D		X				X
Tedesco et al, 2016[71]	P	P			M	X	X	
Triller and Hamilton, 2007[97]	P	P			H	X		
Walker et al, 2009[73]	D	D		X	T	X		
Pharmacy personnel integrated into transition-of-care team								
Favors intervention[b]								
Cavanaugh et al, 2014[49]	P	P			C	X		
Dedhia et al, 2009[51]	A	D		X				
Gil et al, 2013[55]	A, D, P	D, P	X	X	T			
Jack et al, 2009[81]		P		X	T	X		
Koehler et al, 2009[82]	A, D, P	I, D, P			T	X		
Rainville, 1999[87]		D, P	X	X	T	X		
Rice et al, 2016[89]	A, D, P			X	M			

(continued)

Table 4. (continued)

Author, Publication Date	Medication Reconciliation	Patient Counseling	Improved Medication Access	Discharge Plan Development	Patient-Centered Follow-up	HCP-Centered Follow-up	Medication Adherence Tool Given	Other[a]
Ryan et al, 2014[65]		D			T			
Schnipper et al, 2009[91]	A, D							X
Positive trend[c]								
Daley, 2010[76]	A, D, P	I		X	M	X		
Jackson et al, 2013[58]	D, P	D, P	X		M			
Keller et al, 2013[59]						X		
Powers et al, 2014[64]	P	P			M	X		
No difference[d]								
Booth et al, 2014[47]	P	P			T	X	X	
Englander et al, 2014[38]	D	D	X		M	X		X
Reichard et al, 2015[88]		D	X					
Setter et al, 2009[93]	P				H	X		
Stranges et al, 2015[70]	P	P	X		M	X	X	
Not reported[f]								
Sides et al, 2012[95]		P			T	X		

Abbreviations: A, intervention conducted at admission; C, clinic visit; D, intervention conducted at discharge; H, home visit; HCP, health care provider; I, intervention conducted during inpatient stay; M, combination of telephone, home, and/or clinic visit; P, intervention conducted posthospitalization; T, telephone call; X, intervention included in study.

[a]Other intervention components included the following: provided updated medication list to outpatient, community pharmacy;[75] performed chart review to identify and resolve any medication-related problems found;[38] medication recommendations presented to inpatient providers;[91] workflow redesigned from information technology standpoint;[69] or system integration with monthly meetings.[96]

[b]Study results favored the intervention if the study-reported primary outcome was significantly lower compared with usual care.

[c]Study results were positively trending in favor of the intervention when no *P* value was reported but the study-reported primary outcome was lower compared with usual care.

[d]Study results were no different if the study-reported primary outcome was not significantly different between intervention and usual care groups.

[e]Intervention included for enhanced group only.

[f]Study results were not reported in a way such that statistical significance or trends for the primary outcome could be interpreted.

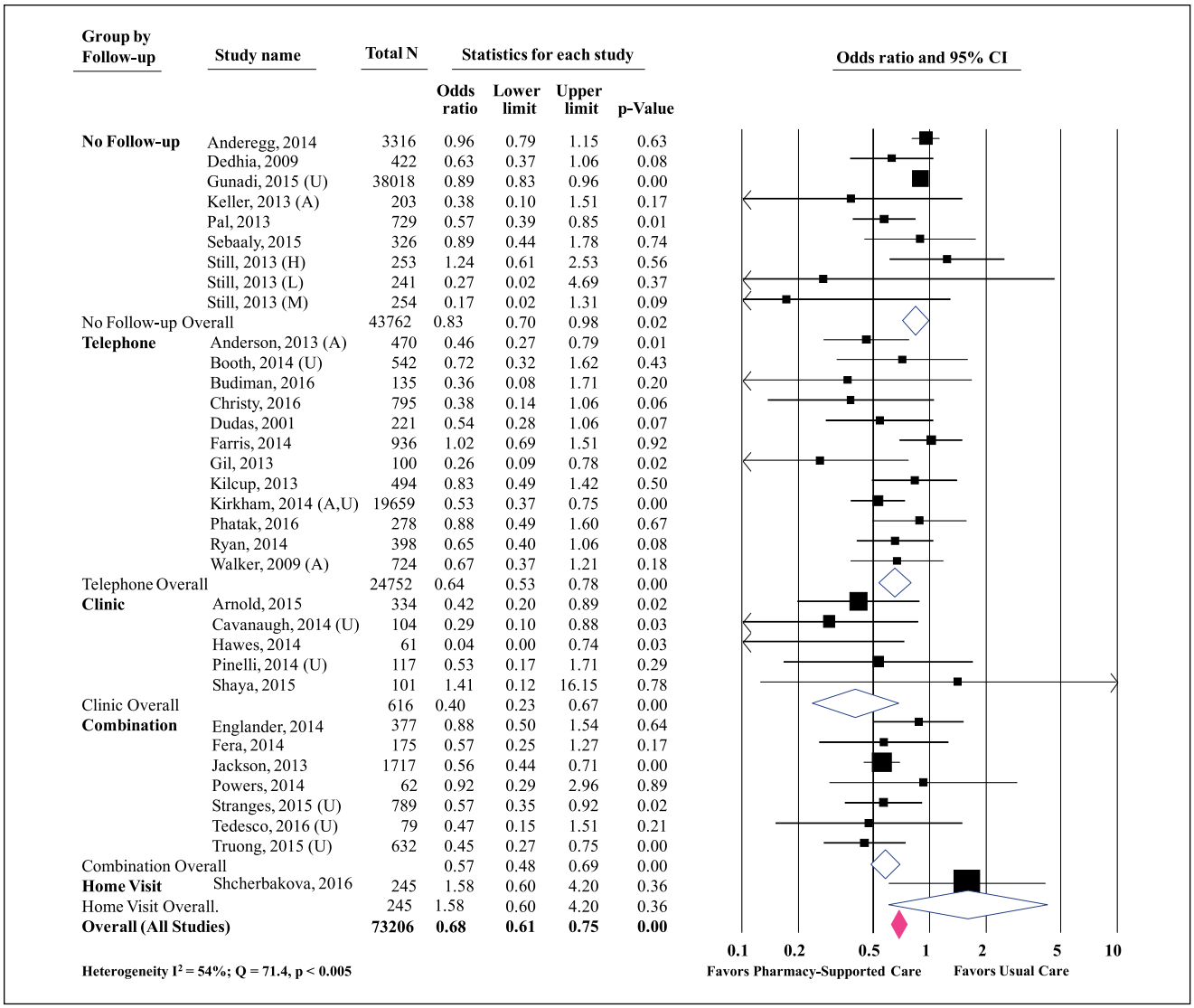

Figure 2. Effect of pharmacy-supported care with patient-centered follow-up (telephonic, clinic, combination, home visit, or no follow-up) compared with usual care on 30-day readmissions. No follow-up = pharmacy-supported care without patient-centered follow-up. Combination = 2 or more types of follow-up provided. Home visit = in-home visit by pharmacist. Citations marked with (A) are studies that used multivariate analysis to control for confounders; citations marked with (U) are studies that used admissions, not patients, as the unit of analysis; citations marked with H = high risk patients, M = moderate risk, and L = low risk. Compared with those without a patient-centered follow-up component, clinic visits and combination care showed significant reductions in the odds of readmission ($P = 0.009$ and $P = 0.003$, respectively); however, telephonic interventions were statistically similar ($P = 0.052$). Differences between telephonic, clinic, and combination care were not significant, $P > 0.07$.

targeted for intervention (Supplementary Appendix Table 5), and (3) study methods used (Supplementary Appendix Table 6). Effect of pharmacy intervention was beneficial on 30-day readmissions regardless of touchpoint frequency, improved medication access, discharge plan development, or whether pharmacy personnel were acting solely or part of the care team (Supplementary Appendix Table 4). Studies with retrospective controlled before-and-after designs had the largest variability in 30-day readmission effect sizes across studies ($I^2 = 66\%$; $P = 0.005$).

Evidence of publication bias was not identified (Kendall's τ with continuity correction P value =0.86). The publication bias funnel plot (Supplementary Appendix Figure 1) indicated that studies missing from the analysis were smaller in size and reported minimal or no effect on the pharmacy-supported TOC intervention. When missing studies were imputed to investigate the potential effect on the result, the authors found that adding extra studies had no significant impact on the overall readmission OR (study imputed OR = 0.69; 95% CI = 0.60, 0.79). The 1-study

Table 5. Influence of Patient-Centered Follow-up Care on 30-Day Readmissions.

Subgroup Category (Number of Studies)	OR	95% CI	[I^2][a] (P Value[b])	Between-Study Difference, P Value	Effect Size for Comparison[c]
Patient-centered follow-up care					
No follow-up (9)	0.829	0.705, 0.975	36% (0.127)	0.006	0.167
Patient-centered follow-up (25)	0.612	0.532, 0.705	18% (0.206)	—	—
Overall (34)	0.697	0.627, 0.775	54% (<0.001)	—	—
Patient-centered follow-up care subcategories					
No follow-up (9)	0.829	0.705, 0.975	36% (0.127)	0.003	0.407[d]
Telephonic (12)	0.644	0.529, 0.783	23% (0.216)	—	—
Clinic (5)	0.396	0.233, 0.671	0% (0.413)	—	—
Combination care (7)	0.574	0.480, 0.686	0% (0.702)	—	—
Home visit (1)	1.581	0.595, 4.199	0% (1.000)	—	—
Overall (34)	0.678	0.613, 0.749	54% (<0.001)	—	—

Abbreviation: OR, odds ratio.
[a]$I2$ is the percentage of total between-study variation resulting from heterogeneity, where 0% to 40% might not be important, 30% to 60% may represent moderate heterogeneity, 50% to 90% may represent substantial heterogeneity, and 75% to 100% represents considerable heterogeneity.[104]
[b]P value is from the Q-statistic comparing the expected study variability with the observed variability to evaluate whether between-study variation is a result of heterogeneity rather than sampling error.
[c]Difference in ORs represents the absolute difference between the 2 ORs for the groups under comparison, where <0.2 = small, 0.2 to 0.8 = medium, and >0.8 = large.[105]
[d]Difference in ORs for no follow-up and clinic follow-up care.

removed analysis demonstrated that the readmission OR would not significantly change when any individual study was removed (lowest OR = 0.64, 95% CI = 0.55, 0.74; highest OR = 0.67, 95% CI = 0.58, 0.74).

Discussion

The most important findings of this systematic review and meta-analysis were that pharmacy-supported TOC services have a meaningful effect on 30-day readmissions (OR = 0.68; 95% CI = 0.61, 0.75) and were further enhanced when a patient-centered intervention approach was utilized. However, the effect was unrelated to other intervention types, targeted patient populations, touchpoint frequency, or study design type used. Although a significant readmission reduction effect was observed, very few RCTs were included. Articles using other study designs often did not use multivariate analysis techniques to adjust for confounding, and therefore, extraneous heterogeneity was introduced. The overall benefit seen in 30-day all-cause readmissions emphasizes the need for integration of pharmacy services for patients undergoing TOC, particularly those discharged directly home. These results are noteworthy considering that medication management has been previously identified as one of the core pillars of patient difficulties experienced during the TOC process.[98] Thus, emphasis on appropriate medication management is strongly recommended during this high-risk transition period.

Although patient-centered follow-up was the only subgroup to provide statistically significant reduction in 30-day all-cause readmissions, other insightful findings were identified in the systematic review based on qualitative evidence on intervention types and targeted patient populations. A commonly implemented intervention was medication reconciliation,[38,39,44,46-51,53-58,60,62-64,66-80,82,83,85,86,89,91-93,95-97] which often occurred in tandem with patient counseling.[38,39,43,45,47-58,60-65,67-76,78-80-84,86,87,90,92,94-97] These 2 interventions were reported at various times throughout the TOC continuum and may have been repeated as additional touchpoints. Furthermore, there was considerable variation in the types of patients targeted among studies, with medication-related issues most frequently used to define respective populations.[44,46,53-55,57,60,62,69,73-75,78,80,82,84,90,95,96] Despite this, only 12 studies had inclusion criteria related to minimum number of medications,[46,54,57,62,69,73-75,80,82,84,96] and even fewer studies targeted patients according to the number of medication changes[60,69,73,80,95] (see Table 3). This suggests the need for medication-related inclusion criteria, especially given the rising prevalence of polypharmacy.[9]

The findings of this meta-analysis parallel those of the existing literature related to pharmacy-supported TOC interventions' impact on hospital readmissions.[29,32] Two meta-analyses previously conducted applied a narrower search scope for study selection to specifically evaluate the effect of medication reconciliation on postdischarge outcomes, effectively excluding other types of pharmacy-supported care, such as providing postdischarge patient-centered follow-up care.[29,32] Kwan et al[29] used a composite outcome of emergency department visits and hospitalizations within 30 days of discharge and found a significant risk reduction for patients receiving medication reconciliation compared

with control patients (risk ratio [RR] = 0.77; 95% CI = 0.63, 0.95). Mekonnen et al[32] reviewed 15 studies and found that pharmacist-led medication reconciliation significantly decreased all-cause readmissions (RR = 0.81; 95% CI = 0.70, 0.95). To the best of our knowledge, this is the most comprehensive meta-analysis investigating the effect of pharmacy-supported TOC. Our findings augment the existing literature to substantiate an association between pharmacy care and a reduction in the odds of 30-day all-cause readmission.

An overall effect was associated with a variety of interventions, but use of stratified analysis found only 1 factor that was associated with increased impact of pharmacy-supported TOC: patient-centered follow-up care. Using qualitative criteria, Ensing et al[30] identified pharmacist intervention components that appeared to be associated with improved clinical outcomes, including active patient counseling and clinical medication review. Mueller et al[33] identified patient education and follow-up as common elements of pharmacist medication reconciliation interventions that they considered successful. To the extent that the factors identified by Ensing et al and Mueller et al might be consistent with patient-centered follow-up care, the findings of this study are consistent with their observations.

The current findings suggest the importance of considering pharmacy-supported interventions as standards for TOC are developed. Pharmacy personnel are highly trained and uniquely qualified to more accurately reconcile medication and allergy histories as well as provide discharge services that decrease preventable ADEs while simultaneously improving medication adherence.[99,100] Currently, limited opportunities exist for pharmacists to receive reimbursement for cognitive pharmacy services.[101] To illustrate this point, most studies in this systematic review included hospital-based interventions where institutions must rely on innovative ways (eg, grants, reimbursement bundling, and/or cost containment) to fund such services. Thus, future studies are needed to better understand the utility of pharmacy-supported interventions in other settings (eg, community, ambulatory care, and health plan) to provide opportunities for expanded value demonstration and additional reimbursement mechanisms.[102] Furthermore, a gap in the literature exists with regard to reporting polypharmacy or other medication-related criteria (eg, increased total number of medications, medication changes, new medications, or high-risk medications) used for patient inclusion criteria for TOC programs. Given that MRPs are the largest cause of hospital readmissions,[7] it is vital that future studies include pharmacy-supported services to directly address and assess medication-related factors that contribute to readmission, such as polypharmacy.

Several limitations require consideration when interpreting these results. First, the design and quality of studies included in the meta-analysis were important limitations. Most included studies used some type of quasi-experimental design, yet failed to incorporate a statistical methodology to control for confounding factors (eg, patient demographics, comorbidities, and prior hospitalizations).[103] Previous systematic reviews and meta-analyses have also highlighted the paucity of rigorous study designs and head-to-head comparisons of alternative interventions rather than usual care, which has limited the ability to draw conclusions about the most effective pharmacy-supported TOC interventions in improving clinical outcomes.[30,32,33] Second, the degree of pharmacy involvement was often underdescribed, and few studies provided data reporting the extent to which pharmacy-supported interventions were implemented. Similarly, there was a lack of detailed description for the usual care group among the included studies, making it difficult to create a consistent, clear definition for usual care in TOC studies. Third, it was often unclear how the study was conducted with respect to study design and patient inclusion criteria, highlighting the need for standardized reporting. Fourth, readmission data were limited because many of these studies were conducted at single-hospital sites, contributing to possible underestimation of readmissions. Finally, the generalizability of these findings is limited to the patient populations from the included studies and respective outcomes reported. Moreover, the conclusions only reflect those studies conducted within the United States and, therefore, may not apply to TOC programs worldwide.

Overall, this meta-analysis suggests that pharmacy-supported interventions significantly reduce the odds of 30-day all-cause readmissions. In particular, interventions that included a patient-centered follow-up component appear to have the most impact on 30-day readmissions. This is the newest meta-analysis to incorporate the most comprehensive information surrounding this topic. The results of this study demonstrate evidence-based practices to support the integration of pharmacy into TOC services to minimize the risk of hospital readmissions.

Authors' Note

Previous presentations:

1. Poster presentation at the Academy of Managed Care Pharmacy Annual Meeting and Expo; April 7-10, 2015; San Diego, CA.
2. Podium presentation at the Western States Pharmacy Residency Conference; May 20, 2015; San Diego, CA.
3. Podium presentation at the Arizona Pharmacy Association Pharmacy Residency Conference; June 25, 2015; Tucson, AZ.
4. Poster presentation at the Academy of Managed Care Pharmacy Annual Meeting and Expo; April 19-22, 2016; San Francisco, CA.
5. Harrington A, Rodrigues C, Murdock N, et al. Effect of pharmacist-supported transition-of-care program on 30-day readmission rates: a systematic review and meta-analysis. *J Manag Care Spec Pharm*. 2016;22(4a):S117-S118. Abstract only.

Declaration of Conflicting Interests

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Supplementary Material

Supplementary material is available for this article online.

References

1. The Joint Commission. Transitions of care: the need for collaboration across entire care continuum. https://www.jointcommission.org/hot_topic_toc/. Accessed January 19, 2017.
2. Centers for Medicare and Medicaid Services. Hospital Readmissions Reduction Program (HRRP). https://www.cms.gov/medicare/medicare-fee-for-service-payment/acuteinpatientpps/readmissions-reduction-program.html. Accessed January 5, 2017.
3. Zuckerman RB, Sheingold SH, Orav EJ, Ruhter J, Epstein AM. Readmissions, observation, and the hospital readmissions reduction program. *N Engl J Med*. 2016;374:1543-1551. doi:10.1056/NEJMsa1513024
4. van Walraven C, Bennett C, Jennings A, Austin PC, Forster AJ. Proportion of hospital readmissions deemed avoidable: a systematic review. *CMAJ*. 2011;183:E391-E402. doi:10.1503/cmaj.101860
5. Burton R. Health policy brief: improving care transitions. *Health Affairs*. http://www.healthaffairs.org/healthpolicybriefs/brief.php?brief_id=76. Accessed May 17, 2017.
6. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare fee-for-service program. *N Engl J Med*. 2009;360:1418-1428. doi:10.1056/NEJMsa0803563
7. Bonnet-Zamponi D, d'Arailh L, Konrat C, et al. Drug-related readmissions to medical units of older adults discharged from acute geriatric units: results of the Optimization of Medication in AGEd multicenter randomized controlled trial. *J Am Geriatr Soc*. 2013;61:113-121. doi:10.1111/jgs.12037
8. Winterstein AG, Sauer BC, Hepler CD, Poole C. Preventable drug-related hospital admissions. *Ann Pharmacother*. 2002;36:1238-1248. doi:10.1345/aph.1A225
9. Guthrie B, Makubate B, Hernandez-Santiago V, Dreischulte T. The rising tide of polypharmacy and drug-drug interactions: population database analysis 1995-2010. *BMC Med*. 2015;13:74. doi:10.1186/s12916-015-0322-7
10. Leendertse AJ, Egberts AC, Stoker LJ, van den Bemt PM. Frequency of and risk factors for preventable medication-related hospital admissions in the Netherlands. *Arch Intern Med*. 2008;168:1890-1896. doi:10.1001/archinternmed.2008.3
11. Howard RL, Avery AJ, Slavenburg S, et al. Which drugs cause preventable admissions to hospital? A systematic review. *Br J Clin Pharmacol*. 2007;63:136-147. doi:10.1111/j.1365-2125.2006.02698.x
12. Forster AJ, Murff HJ, Peterson JF, Gandhi TK, Bates DW. The incidence and severity of adverse events affecting patients after discharge from the hospital. *Ann Intern Med*. 2003;138:161-167. doi:10.7326/0003-4819-138-3-200302040-00007
13. Forster AJ, Murff HJ, Peterson JF, Gandhi TK, Bates DW. Adverse drug events occurring following hospital discharge. *J Gen Intern Med*. 2005;20:317-323. doi:10.1111/j.1525-1497.2005.30390.x
14. Kanaan AO, Donovan JL, Duchin NP, et al. Adverse drug events after hospital discharge in older adults: types, severity, and involvement of Beers Criteria Medications. *J Am Geriatr Soc*. 2013;61:1894-1899. doi:10.1111/jgs.12504
15. Bell CM, Brener SS, Gunraj N, et al. Association of ICU or hospital admission with unintentional discontinuation of medications for chronic diseases. *JAMA*. 2011;306:840-847. doi:10.1001/jama.2011.1206
16. Scales DC, Fischer HD, Li P, et al. Unintentional continuation of medications intended for acute illness after hospital discharge: a population-based cohort study. *J Gen Intern Med*. 2016;31:196-202. doi:10.1007/s11606-015-3501-5
17. Coleman EA, Smith JD, Raha D, Min SJ. Posthospital medication discrepancies: prevalence and contributing factors. *Arch Intern Med*. 2005;165:1842-1847. doi:10.1001/archinte.165.16.1842
18. Fallis BA, Dhalla IA, Klemensberg J, Bell CM. Primary medication non-adherence after discharge from a general internal medicine service. *PLoS One*. 2013;8:e61735. doi:10.1371/journal.pone.0061735
19. Hajjar ER, Hanlon JT, Sloane RJ, et al. Unnecessary drug use in frail older people at hospital discharge. *J Am Geriatr Soc*. 2005;53:1518-1523. doi:10.1111/j.1532-5415.2005.53523.x
20. Lazarou J, Pomeranz BH, Corey PN. Incidence of adverse drug reactions in hospitalized patients: a meta-analysis of prospective studies. *JAMA*. 1998;279:1200-1205. doi:10.1001/jama.279.15.1200
21. Classen DC, Pestotnik SL, Evans RS, Lloyd JF, Burke JP. Adverse drug events in hospitalized patients: excess length of stay, extra costs, and attributable mortality. *JAMA*. 1997;277:301-306. doi:10.1001/jama.1997.03540280039031
22. Garcia-Caballos M, Ramos-Diaz F, Jimenez-Moleon JJ, Bueno-Cavanillas A. Drug-related problems in older people after hospital discharge and interventions to reduce them. *Age Ageing*. 2010;39:430-438. doi:10.1093/ageing/afq045
23. Isetts BJ, Brummel AR, de Oliveira DR, Moen DW. Managing drug-related morbidity and mortality in the patient-centered medical home. *Med Care*. 2012;50:997-1001. doi:10.1097/MLR.0b013e31826ecf9a
24. Davies EC, Green CF, Mottram DR, Rowe PH, Pirmohamed M. Emergency re-admissions to hospital due to adverse drug reactions within 1 year of the index admission. *Br J Clin Pharmacol*. 2010;70:749-755. doi:10.1111/j.1365-2125.2010.03751.x
25. Leape LL, Cullen DJ, Clapp MD, et al. Pharmacist participation on physician rounds and adverse drug events in the intensive care unit. *JAMA*. 1999;282:267-270. doi:10.1001/jama.282.3.267
26. Kucukarslan SN, Peters M, Mlynarek M, Nafziger DA. Pharmacists on rounding teams reduce preventable adverse drug events in hospital general medicine units.

Arch Intern Med. 2003;163:2014-2018. doi:10.1001/archinte.163.17.2014
27. American Society of Health-System Pharmacists. ASHP statement on the pharmacist's role in medication reconciliation. *Am J Health Syst Pharm*. 2013;70:453-456. doi:10.2146/sp120009
28. Bradley EH, Curry L, Horwitz LI, et al. Contemporary evidence about hospital strategies for reducing 30-day readmissions: a national study. *J Am Coll Cardiol*. 2012;60:607-614. doi:10.1016/j.jacc.2012.03.067
29. Kwan JL, Lo L, Sampson M, Shojania KG. Medication reconciliation during transitions of care as a patient safety strategy: a systematic review. *Ann Intern Med*. 2013;158(5, pt 2):397-403. doi:10.7326/0003-4819-158-5-201303051-00006
30. Ensing HT, Stuijt CC, van den Bemt BJ, et al. Identifying the optimal role for pharmacists in care transitions: a systematic review. *J Manag Care Spec Pharm*. 2015;21:614-636. doi:http://dx.doi.org/10.18553/jmcp.2015.21.8.614
31. Hammad EA, Bale A, Wright DJ, Bhattacharya D. Pharmacy led medicine reconciliation at hospital: a systematic review of effects and costs. *Res Social Adm Pharm*. 2017;13:300-312. doi:10.1016/j.sapharm.2016.04.007
32. Mekonnen AB, McLachlan AJ, Brien JA. Effectiveness of pharmacist-led medication reconciliation programmes on clinical outcomes at hospital transitions: a systematic review and meta-analysis. *BMJ Open*. 2016;6:e010003. doi:10.1136/bmjopen-2015-010003
33. Mueller SK, Sponsler KC, Kripalani S, Schnipper JL. Hospital-based medication reconciliation practices: a systematic review. *Arch Intern Med*. 2012;172:1057-1069. doi:10.1001/archinternmed.2012.2246
34. Spinewine A, Claeys C, Foulon V, Chevalier P. Approaches for improving continuity of care in medication management: a systematic review. *Int J Qual Health Care*. 2013;25:403-417. doi:10.1093/intqhc/mzt032
35. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Ann Intern Med*. 2009;151:264-269, w64. doi:10.7326/0003-4819-151-4-200908180-00135
36. Sterne JAC, Higgins JPT, Reeves BC; On Behalf of the Development Group for ACROBAT-NRSI. A Cochrane risk of bias assessment tool: for non-randomized studies of interventions (ACROBAT-NRSI), version 1.0.0. http://www.riskofbias.info/. Accessed May 17, 2017.
37. Higgins JPT, Altman DG, Stearne JAC, eds. Assessing risk of bias in included studies. In: Higgins JPT, Green S, eds. *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0*. http://www.cochrane-handbook.org. Accessed January 12, 2017.
38. Englander H, Michaels L, Chan B, Kansagara D. The care transitions innovation (C-TraIn) for socioeconomically disadvantaged adults: results of a cluster randomized controlled trial. *J Gen Intern Med*. 2014;29:1460-1467. doi:10.1007/s11606-014-2903-0
39. Kripalani S, Roumie CL, Dalal AK, et al. Effect of a pharmacist intervention on clinically important medication errors after hospital discharge: a randomized trial. *Ann Intern Med*. 2012;157:1-10. doi:10.7326/0003-4819-157-1-201207030-00003
40. Bland JM, Altman DG. Statistics notes: the odds ratio. *BMJ*. 2000;320:1468.
41. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ*. 2003;327:557-560. doi:10.1136/bmj.327.7414.557
42. Begg CB, Mazumdar M. Operating characteristics of a rank correlation test for publication bias. *Biometrics*. 1994;50:1088-1101. doi:10.2307/2533446
43. Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ*. 1997;315:629-634. doi:https://doi.org/10.1136/bmj.315.7109.629
44. Anderegg SV, Wilkinson ST, Couldry RJ, Grauer DW, Howser E. Effects of a hospitalwide pharmacy practice model change on readmission and return to emergency department rates. *Am J Health Syst Pharm*. 2014;71:1469-1479. doi:10.2146/ajhp130686
45. Anderson SL, Marrs JC, Vande Griend JP, Hanratty R. Implementation of a clinical pharmacy specialist-managed telephonic hospital discharge follow-up program in a patient-centered medical home. *Popul Health Manag*. 2013;16:235-241. doi:10.1089/pop.2012.0070
46. Arnold ME, Buys L, Fullas F. Impact of pharmacist intervention in conjunction with outpatient physician follow-up visits after hospital discharge on readmission rate. *Am J Health Syst Pharm*. 2015;72(11, suppl 1):S36-S42. doi:10.2146/sp150011
47. Booth KA, Vinci LM, Oyler JL, Pincavage AT. Using a resident discharge clinic for resident education and patient care: a feasibility study. *J Grad Med Educ*. 2014;6:536-540. doi:10.4300/JGME-D-13-00313.1
48. Budiman T, Snodgrass K, Komatsu Chang A. Evaluation of pharmacist medication education and post-discharge follow-up in reducing readmissions in patients with ST-segment elevation myocardial infarction (STEMI). *Ann Pharmacother*. 2016;50:118-124. doi:10.1177/1060028015620425
49. Cavanaugh JJ, Jones CD, Embree G, et al. Implementation science workshop: primary care-based multidisciplinary readmission prevention program. *J Gen Intern Med*. 2014;29:798-804. doi:10.1007/s11606-014-2819-8
50. Christy S, Sin B, Gim S. Impact of an integrated pharmacy transitions of care pilot program in an urban hospital. *J Pharm Pract*. 2016;29:490-494. doi:10.1177/0897190014568674
51. Dedhia P, Kravet S, Bulger J, et al. A quality improvement intervention to facilitate the transition of older adults from three hospitals back to their homes. *J Am Geriatr Soc*. 2009;57:1540-1546. doi:10.1111/j.1532-5415.2009.02430.x
52. Dudas V, Bookwalter T, Kerr KM, Pantilat SZ. The impact of follow-up telephone calls to patients after hospitalization. *Am J Med*. 2001;111(9b):26s-30s.
53. Farris KB, Carter BL, Xu Y, et al. Effect of a care transition intervention by pharmacists: an RCT. *BMC Health Serv Res*. 2014;14:406. doi:10.1186/1472-6963-14-406
54. Fera T, Anderson C, Kanel KT, Ramusivich DL. Role of a care transition pharmacist in a primary care resource center. *Am J Health Syst Pharm*. 2014;71:1585-1590. doi:10.2146/ajhp130684

55. Gil M, Mikaitis DK, Shier G, Johnson TJ, Sims S. Impact of a combined pharmacist and social worker program to reduce hospital readmissions. *J Manag Care Pharm*. 2013;19:558-563. doi:http://dx.doi.org/10.18553/jmcp.2013.19.7.558
56. Gunadi S, Upfield S, Pham ND, Yea J, Schmiedeberg MB, Stahmer GD. Development of a collaborative transitions-of-care program for heart failure patients. *Am J Health Syst Pharm*. 2015;72:1147-1152. doi:10.2146/ajhp140563
57. Hawes EM, Maxwell WD, White SF, Mangun J, Lin FC. Impact of an outpatient pharmacist intervention on medication discrepancies and health care resource utilization in posthospitalization care transitions. *J Prim Care Community Health*. 2014;5:14-18. doi:10.1177/2150131913502489
58. Jackson CT, Trygstad TK, DeWalt DA, DuBard CA. Transitional care cut hospital readmissions for North Carolina Medicaid patients with complex chronic conditions. *Health Aff (Millwood)*. 2013;32:1407-1415. doi:10.1377/hlthaff.2013.0047
59. Keller SC, Ciuffetelli D, Bilker W, et al. The impact of an infectious diseases transition service on the care of outpatients on parenteral antimicrobial therapy. *J Pharm Technol*. 2013;29:205-214. doi:10.1177/8755122513500922
60. Kilcup M, Schultz D, Carlson J, Wilson B. Postdischarge pharmacist medication reconciliation: impact on readmission rates and financial savings. *J Am Pharm Assoc*. 2013;53:78-84. doi:10.1331/JAPhA.2013.11250
61. Kirkham HS, Clark BL, Paynter J, Lewis GH, Duncan I. The effect of a collaborative pharmacist-hospital care transition program on the likelihood of 30-day readmission. *Am J Health Syst Pharm*. 2014;71:739-745. doi:10.2146/ajhp130457
62. Phatak A, Prusi R, Ward B, et al. Impact of pharmacist involvement in the transitional care of high-risk patients through medication reconciliation, medication education, and postdischarge call-backs (IPITCH Study). *J Hosp Med*. 2016;11:39-44. doi:10.1002/jhm.2493
63. Pinelli NR, Clark LM, Carrington AC, Carrington JL, Malinzak L, Patel A. Pharmacist managed diabetes and cardiovascular risk reduction clinic in kidney transplant recipients: bridging the gap in care transition. *Diabetes Res Clin Pract*. 2014;106:e64-e67. doi:10.1016/j.diabres.2014.09.034
64. Powers JS, Cox Z, Young J, Howell M, DiSalvo T. Critical pathways: implementation of the Coleman Care Transitions Program in individuals hospitalized with congestive heart failure. *J Am Geriatr Soc*. 2014;62:2442-2444. doi:10.1111/jgs.13174
65. Ryan J, Andrews R, Barry MB, et al. Preventability of 30-day readmissions for heart failure patients before and after a quality improvement initiative. *Am J Med Qual*. 2014;29:220-226. doi:10.1177/1062860613496135
66. Sebaaly J, Parsons LB, Pilch NA, Bullington W, Hayes GL, Easterling H. Clinical and financial impact of pharmacist involvement in discharge medication reconciliation at an academic medical center: a prospective pilot study. *Hosp Pharm*. 2015;50:505-513. doi:10.1310/hpj5006-505
67. Shaya FT, Chirikov VV, Rochester C, Zaghab RW, Kucharski KC. Impact of a comprehensive pharmacist medication-therapy management service. *J Med Econ*. 2015;18:828-837. doi:10.3111/13696998.2015.1052463
68. Shcherbakova N, Tereso G. Clinical pharmacist home visits and 30-day readmissions in Medicare Advantage beneficiaries. *J Eval Clin Pract*. 2016;22:363-368. doi:10.1111/jep.12495
69. Still KL, Davis AK, Chilipko AA, Jenkosol A, Norwood DK. Evaluation of a pharmacy-driven inpatient discharge counseling service: impact on 30-day readmission rates. *Consult Pharm*. 2013;28:775-785. doi:10.4140/TCP.n.2013.775
70. Stranges PM, Marshall VD, Walker PC, Hall KE, Griffith DK, Remington T. A multidisciplinary intervention for reducing readmissions among older adults in a patient-centered medical home. *Am J Manag Care*. 2015;21:106-113.
71. Tedesco GW, McConaha JL, Skomo ML, Higginbotham SK. A pharmacist's impact on 30-day readmission rates when compared to the current standard of care within a patient-centered medical home: a pilot study. *J Pharm Pract*. 2016;29:368-373. doi:10.1177/0897190014568671
72. Truong JT, Backes AC. The impact of a continuum of care resident pharmacist on heart failure readmissions and discharge instructions at a community hospital. *SAGE Open Med*. 2015;3:2050312115577986. doi:10.1177/2050312115577986
73. Walker PC, Bernstein SJ, Jones JN, et al. Impact of a pharmacist-facilitated hospital discharge program: a quasi-experimental study. *Arch Intern Med*. 2009;169:2003-2010. doi:10.1001/archinternmed.2009.398
74. Pal A, Babbott S, Wilkinson ST. Can the targeted use of a discharge pharmacist significantly decrease 30-day readmissions? *Hosp Pharm*. 2013;48:380-388. doi:10.1310/hpj4805-380
75. Calvert SB, Kramer JM, Anstrom KJ, Kaltenbach LA, Stafford JA, Allen LaPointe NM. Patient-focused intervention to improve long-term adherence to evidence-based medications: a randomized trial. *Am Heart J*. 2012;163:657-65.e1. doi:10.1016/j.ahj.2012.01.019
76. Daley CM. A hybrid transitional care program. *Crit Pathw Cardiol*. 2010;9:231-234. doi:10.1097/HPC.0b013e3182018838
77. Eisenhower C. Impact of pharmacist-conducted medication reconciliation at discharge on readmissions of elderly patients with COPD. *Ann Pharmacother*. 2014;48:203-208. doi:10.1177/1060028013512277
78. Gilmore V, Efird L, Fu D, LeBlanc Y, Nesbit T, Swarthout M. Implementation of transitions-of-care services through acute care and outpatient pharmacy collaboration. *Am J Health Syst Pharm*. 2015;72:737-744. doi:10.2146/ajhp140504
79. Ho PM, Lambert-Kerzner A, Carey EP, et al. Multifaceted intervention to improve medication adherence and secondary prevention measures after acute coronary syndrome hospital discharge: a randomized clinical trial. *JAMA Intern Med*. 2014;174:186-193. doi:10.1001/jamainternmed.2013.12944
80. Imberg AJ, Swanoski MT, Renier CM, Sorensen TD. Maximizing medication therapy management services through a referral initiative. *Am J Health Syst Pharm*. 2012;69:1234-1239. doi:10.2146/ajhp110511
81. Jack BW, Chetty VK, Anthony D, et al. A reengineered hospital discharge program to decrease rehospitalization: a randomized trial. *Ann Intern Med*. 2009;150:178-187.
82. Koehler BE, Richter KM, Youngblood L, et al. Reduction of 30-day postdischarge hospital readmission or emergency

department (ED) visit rates in high-risk elderly medical patients through delivery of a targeted care bundle. *J Hosp Med*. 2009;4:211-218. doi:10.1002/jhm.427

83. Kogut SJ, Goldstein E, Charbonneau C, Jackson A, Patry G. Improving medication management after a hospitalization with pharmacist home visits and electronic personal health records: an observational study. *Drug Healthc Patient Saf*. 2014;6:1-6. doi:10.2147/DHPS.S56574
84. Lipton HL, Bird JA. The impact of clinical pharmacists' consultations on geriatric patients' compliance and medical care use: a randomized controlled trial. *Gerontologist*. 1994;34:307-315. doi:10.1093/geront/34.3.307
85. Musgrave CR, Pilch NA, Taber DJ, et al. Improving transplant patient safety through pharmacist discharge medication reconciliation. *Am J Transplant*. 2013;13:796-801. doi:10.1111/ajt.12070
86. Paquin AM, Salow M, Rudolph JL. Pharmacist calls to older adults with cognitive difficulties after discharge in a tertiary Veterans Administration Medical Center: a quality improvement program. *J Am Geriatr Soc*. 2015;63:571-577. doi:10.1111/jgs.13315
87. Rainville EC. Impact of pharmacist interventions on hospital readmissions for heart failure. *Am J Health Syst Pharm*. 1999;56:1339-1342.
88. Reichard JS, Savage S, Eckel SF. Pharmacy-initiated transitions of care services: an opportunity to impact patient satisfaction. *Hosp Pharm*. 2015;50:911-917. doi:10.1310/hpj5010-911
89. Rice YB, Barnes CA, Rastogi R, Hillstrom TJ, Steinkeler CN. Tackling 30-day, all-cause readmissions with a patient-centered transitional care bundle. *Popul Health Manag*. 2016;19:56-62. doi:10.1089/pop.2014.0163
90. Schillig J, Kaatz S, Hudson M, Krol GD, Szandzik EG, Kalus JS. Clinical and safety impact of an inpatient pharmacist-directed anticoagulation service. *J Hosp Med*. 2011;6:322-328. doi:10.1002/jhm.910
91. Schnipper JL, Hamann C, Ndumele CD, et al. Effect of an electronic medication reconciliation application and process redesign on potential adverse drug events: a cluster-randomized trial. *Arch Intern Med*. 2009;169:771-780. doi:10.1001/archinternmed.2009.51
92. Schnipper JL, Kirwin JL, Cotugno MC, et al. Role of pharmacist counseling in preventing adverse drug events after hospitalization. *Arch Intern Med*. 2006;166:565-571. doi:10.1001/archinte.166.5.565
93. Setter SM, Corbett CF, Neumiller JJ, Gates BJ, Sclar DA, Sonnett TE. Effectiveness of a pharmacist-nurse intervention on resolving medication discrepancies for patients transitioning from hospital to home health care. *Am J Health Syst Pharm*. 2009;66:2027-2031. doi:10.2146/ajhp080582
94. Shah M, Norwood CA, Farias S, Ibrahim S, Chong PH, Fogelfeld L. Diabetes transitional care from inpatient to outpatient setting: pharmacist discharge counseling. *J Pharm Pract*. 2013;26:120-124. doi:10.1177/0897190012451907
95. Sides EG, Zimmer LO, Wilson L, et al. Medication coaching program for patients with minor stroke or TIA: a pilot study. *BMC Public Health*. 2012;12:549. doi:10.1186/1471-2458-12-549
96. Trang J, Martinez A, Aslam S, Duong MT. Pharmacist advancement of transitions of care to home (PATCH) service. *Hosp Pharm*. 2015;50:994-1002. doi:10.1310/hpj5011-994
97. Triller DM, Hamilton RA. Effect of pharmaceutical care services on outcomes for home care patients with heart failure. *Am J Health Syst Pharm*. 2007;64:2244-2249. doi:10.2146/ajhp050492
98. Coleman EA, Smith JD, Frank JC, Eilertsen TB, Thiare JN, Kramer AM. Development and testing of a measure designed to assess the quality of care transitions. *Int J Integr Care*. 2002;2(2):1-9.
99. Balling L, Erstad BL, Weibel K. Impact of a transition-of-care pharmacist during hospital discharge. *J Am Pharm Assoc (2003)*. 2015;55:44344-8. doi:10.1331/JAPhA.2015.14087
100. Nester TM, Hale LS. Effectiveness of a pharmacist-acquired medication history in promoting patient safety. *Am J Health Syst Pharm*. 2002;59:2221-2225.
101. American Society of Health-System Pharmacists. Pharmacist billing for ambulatory pharmacy patient care services in a physician-based clinic and other non-hospital-based environments: FAQ. 2014. http://www.ashp.org/doclibrary/policy/ambulatory-care/pharmacist-billing-in-physician-based-clinic-faq.pdf. Accessed January 19, 2017.
102. Centers for Medicare and Medicaid Services. Transitional care management services. https://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/Downloads/Transitional-Care-Management-Services-Fact-Sheet-ICN908628.pdf. Accessed January 19, 2017.
103. Donze JD, Williams MV, Robinson EJ, et al. International validity of the HOSPITAL score to predict 30-day potentially avoidable hospital readmissions. *JAMA Intern Med*. 2016;176:496-502. doi:10.1001/jamainternmed.2015.8462
104. Deeks JJ, Higgins JPT, Altman DG, eds; On Behalf of the Cochrane Statistical Methods Group. Analysing data and undertaking meta-analyses. In: Higgins JPT, Green S, eds. *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0*. 2011:chap 9. http://www.handbook.cochrane.org. Accessed January 12, 2017.
105. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum; 1988:567.